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Editorial

The Data-Driven Continuum: From Clinical Insights to Enhanced Patient Care and Population Health

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Abstract:

This editorial explores the transformative role of data analytics in healthcare, bridging clinical insights, personalized patient care, and population health management. By leveraging real-world data, predictive modeling, and AI, we highlight how data-driven strategies optimize treatment outcomes, enhance decision-making, and improve public health interventions—creating a seamless continuum from individual care to systemic health advancements.

Keywords: Data-driven healthcare; Clinical analytics; Population health; Precision medicine

Introduction

Population health improvement demands a holistic and integrated understanding of health across the life cycle—from birth to end-of-life—and the broad determinants of health, including social, environmental, and clinical factors. Seamless integration of diverse information systems to capture, analyze, and act on data that spans life stages and contexts, and interoperable systems are critical to bridging gaps between clinical care, public health, and social services.

As health systems transition toward value-based care and population health management, the intelligent use of data is as essential as breakthrough treatments. Innovation and quality improvement has to be driven by the iterative process of data collection, advanced analysis and effective implementation, in a dynamic continuum from patient-level data to health system transformation and population health improvement (1).

Health outcomes are not isolated events but the cumulative result of interactions across an individual's life. Prenatal care influences childhood development, adolescent behaviors shape adult chronic disease risk, and geriatric care impacts quality of life in later years. The determinants of health—such as socioeconomic status, education, housing, environmental exposures, and access to care—profoundly affect health trajectories. Health information systems must adopt a life cycle perspective, tracking individuals and populations over time.

Laying the Foundation: Robust Clinical Data Collection

The systematic collection of clinical data is the first stpet in this process. High-quality datasets—whether from electronic health records (EHR), disease registries, or longitudinal studies—is the foundation of data-based decision-making (2). From managing chronic diseases such as heart failure, diabetes, and viral hepatitis to classifying complex conditions like endometriosis, or identifying patients at risk of sepsis,

the comprehensiveness and standardization of data are paramount. These datasets allow for granular insight into patient histories, comorbidities, laboratory and diagnostic tests results, medical notes, enabling clinicians to understand both individual and population-level health trajectories, differences in treatment responses, supporting clinical and epidemiological research, and improving health care systems. Secure data exchanges and interoperability across organizations have to connect hospitals, primary care, public health agencies, and social services.

From Data to Knowledge: Advanced Analytical Approaches

EHRs are the backbone of clinical data, capturing patient encounters, diagnoses, treatments, and outcomes. To support a life cycle perspective, EHRs must be longitudinal, interoperable, and standardized to track health data across providers and settings but also incorporating data on education, employment, or environmental exposures. For example, integrating pediatric and adult EHRs ensures continuity of care for chronic conditions like diabetes diagnosed in childhood.

Disease registries and syndromic surveillance platforms provide population-level insights into health trends, outbreaks, and disparities, allowing for real-time monitoring of determinants such as environmental exposures (e.g., air quality) or social risks (e.g., poverty rates).

Specialized platforms collect data on non-clinical factors, such as employment, education, and community resources. Integrating Determinants of Health data into clinical workflows via EHRs enables providers to tailor interventions, such as referring patients to community programs for housing support.

Wearables, mobile apps, and remote monitoring devices (e.g., continuous glucose monitors) generate real-time data on physical activity, vital signs, and medication adherence, offering insights into daily health behaviors across life stages. Data collected from patient devices, such as smartphones, wearable trackers, or disease-specific monitors (e.g., continuous glucose monitors or cardiac rhythm devices), can also be integrated into EHR through secure health information exchange platforms and interoperable software, enabling real-time or periodic transmission of patient-generated health data—such as physical activity, heart rate, glucose levels, or medication adherence—into the clinical workflow, offering the possibility to tracking patterns over hours, days, and weeks. By enriching EHRs with continuous and contextual health data, clinicians may gain a more comprehensive view of a patient's condition, support personalized treatment plans, and enable earlier interventions, ultimately improving care coordination and health outcomes (3).

Genomic data, increasingly relevant for personalized medicine, informs risk profiles for conditions like cancer or cardiovascular disease. Integrating genomic databases with EHRs supports tailored prevention and treatment strategies over a patient's lifetime (4,5).

After being collected, data must be transformed into actionable knowledge. Specific data science techniques that may be applied include machine learning algorithms such as logistic regression, random forests, and gradient boosting for predictive modeling of outcomes like hospital readmissions or disease progression (6). Natural language processing (NLP) can extract clinically relevant information from unstructured notes, such as symptoms or social determinants of health. Clustering techniques, like k-means or hierarchical clustering, help identify patient subgroups with similar characteristics or risk profiles (7) based on unobserved associations (8). Time-series analysis enables monitoring of patient parameters over time, while survival analysis is useful for estimating time-to-event outcomes (9,10).

Integrating these systems faces significant hurdles, including data silos, inconsistent standards, and privacy concerns. For instance, proprietary EHR systems often lack interoperability, while data on social or physical environment may be unstructured or incomplete or not availalbe at individual level. To overcome these challenges, health systems must adopt standardized frameworks to ensure seamless data exchange. Robust governance policies, are essential to protect patient privacy while enabling data sharing.

These approaches may reveal patterns of disease burden, identify population subgroups with specific healthcare needs,support risk stratification and guide the development of more effective, personalized care strategies. Aggregating data across populations helps in refining national treatment guidelines and optimizing resource allocation.

Closing the Loop: Learning Health Systems

A population life cycle and determinants of health perspective is within reach if we commit to integrating diverse information systems into a unified data ecosystem. By breaking down silos and harnessing the power of data, we can create a healthcare system that is proactive but also preventive and equitable. The future of population health lies in our ability to connect the dots—a life cycle and determinants of health perspective.

As the ultimate goal of data collection and analysis to is to translate insights into improved clinical practice and patient care, healthcare systems must integrate data collection, analysis, and feedback into routine care. This step calls for interoperable digital infrastructure, real-time analytics, and automated decision support tools embedded in clinical workflows, but also a robust implementation science framework and cross-disciplinary collaboration among data scientists, informaticians, and medical professionals essential to translate insights into practical interventions, adapting the knowledge to local contexts, to ensure that findings are relevant, understandable, and actionable. Evaluation, feedback loops, and policy support reinforce data-driven improvements, making sure that evidence not only informs care but also leads to measurable patient outcomes.

Transforming clinical data into effective patient care requires more than technology—it requires vision, collaboration, and an unwavering commitment to impact, to transform raw data into actionable insights, identifying high-risk populations or predicting disease progression (11).

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Review Article

Malaria-Typhoid Fever Diagnostic Confusion in Nigeria and Its Impact on Treatment Delays and Mortality Among Pregnant Women and Children

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Abstract:

In Nigeria, typhoid fever and malaria continue to be the leading causes of feverish sickness, particularly in children and pregnant women. Accurate diagnosis is difficult in locations with limited resources since both diseases are endemic and feature overlapping symptoms, such as high fever, malaise, and gastrointestinal distress. Frequent misdiagnosis is a result of this diagnostic overlap as well as systemic healthcare flaws such the Widal test's dependence, the varied sensitivity of malaria rapid diagnostic tests (RDTs), and inadequate laboratory equipment. Traditional beliefs and self-medication are examples of community-level influences that also contribute. These difficulties lead to improper administration of antibiotics, delays in treatment, and higher mortality, especially among vulnerable populations. The epidemiology, clinical overlap, and diagnostic difficulties of typhoid fever and malaria in Nigeria are summarized in this article. It draws attention to the negative effects of incorrect diagnosis, such as treatment failure, antibiotic resistance, and poor maternal-child health outcomes. The report urges system-wide changes, public education, better healthcare worker training, and enhanced diagnostics such multiplex assays and more precise RDTs. Investing in water and sanitation infrastructure, regulating unlicensed healthcare practitioners, and improving surveillance systems are some of the main proposals. Reducing diagnostic ambiguity, enhancing clinical results, and safeguarding high-risk groups all depend on filling these gaps.

Keywords: Malaria; Typhoid Fever; Diagnostic Challenges; Pregnant Women and Children; Nigeria

Introduction

Malaria and typhoid fever constitute remarkably major public health problems in Nigeria, as both diseases are equally endemic and form a large proportion of the national burden of fevers. Malaria is the leading cause of morbidity and one of the major causes of death, especially in children under five and the library of pregnant women [1]. Typhoid fever, caused by S. enterica serotypes Typhi or Paratyphi, is also endemic, largely as a result of inadequate water sanitation and hygienic facilities. These infections frequently overlap when they occur in parallel geographic and demographic environments, complicating efforts to diagnose and treat them in an overstretched national healthcare system [2].

Appropriate diagnosis of febrile conditions is important in such resource-limited settings as Nigeria. However, similar clinical presentation of malaria and typhoid, including prolonged fever, headache, easy fatiguability, and gastrointestinal symptoms, makes it challenging to differentiate them on a clinical basis [3]. The problem is often compounded by the absence of affordable and accessible diagnostic tools, resulting in empirical therapy, misdiagnosis, or inappropriate polypharmacy. These issues are heightened in rural and primary care facilities that have diminished diagnostic capabilities [4].

Pregnant women and young children are less capable of withstanding the effects of incorrect diagnoses. Among pregnant women, untreated or poorly treated malaria can lead to maternal anaemia, stillbirth, preterm delivery, and low-birth-weight infants [5]. Complicated by typhoid fever when not treated or managed properly, can result in intestinal perforation and sepsis, with a very high risk of maternal and fetal morbidities. In children, failure to be managed properly or timely manner will increase the possibility of severe complications, long-term developmental impairment, or even death [6].

We conducted this review to critically analyze the diagnostic confusion and misdiagnosis associated with malaria and typhoid fever in Nigeria, the implications of which are treatment delay and mortality in pregnant women and children. It examines epidemiological patterns, limitations of diagnosis, healthcare services, and the overall impact on clinical outcomes. This review aims to critically examine the diagnostic confusion between malaria and typhoid fever in Nigeria and its impact on treatment delays and health outcomes in pregnant women and children. We hypothesize that overlapping clinical features, weak diagnostic systems, and sociocultural practices contribute significantly to diagnostic inaccuracies and adverse outcomes. By synthesizing the current evidence, this review seeks to identify systemic gaps and propose actionable solutions to improve diagnostic accuracy and reduce mortality. The findings are particularly important in informing public health strategies in low-resource settings where malaria and typhoid fever are co-endemic.

Methods Malaria and Typhoid Fever in Nigeria: An Overview

Malaria

Malaria is still responsible for a significant proportion of ill-health and death in Nigeria, with 27% of the global malaria burden [7]. Transmission exists throughout the year, and peaks during the rainy season and the immediate months thereafter, from May to October, approximately. The disease is largely spread by the Anopheles mosquito, which breeds in the tropical climate and the standing water it creates, factors prevalent in much of the country [8]. Plasmodium falciparum is the predominant species in Nigeria, causing the most serious form of malaria. This species has a strong possibility of obtaining transferability and drug resistance, which can bring the treatment to a deadlock [9]. Recurrent episodes of malaria cause high maternal and child morbidity. During pregnancy, it raises the risk of maternal anemia, abortion, stillbirth, prematurity, and low birth weight. Malaria is a leading cause of hospitalization and death in children under 5 and leads to developmental delays and weakened immunity to other infections [10].

Typhoid Fever

Although true malaria-typhoid co-infections do occur, data from recent hospital-based studies suggest that up to 30–50% of reported co-infections may be due to diagnostic inaccuracies stemming from false-positive tests or overlapping symptoms [11].

Typhoid fever in Nigeria is predominantly due to Salmonella enterica serovar Typhi but is also caused by serovar Paratyphi. To get accurate national incidence data will be difficult given both underreporting and difficulties with diagnosis, but existing evidence suggests

high levels of endemicity, particularly in densely populated and underresourced regions [12]. High prevalence is enhanced by a lack of safe drinking water access, poor sanitation, and limited sanitary practices—all prevailing in slums and rural settings.

The Widal test has limited specificity and sensitivity, with a consequently high likelihood of under- or over-reporting of typhoid cases. Blood culture is still the gold standard, but is hardly accessible in most Nigerian hospitals because of cost and facility challenges [13]. Crucially, many studies have also described a disturbing increase in the rate of malaria-typhoid co-infections; however, not all of these conclusions could be well-founded, due to diagnostic errors. Real co-infections are possible because of shared transmission risks, but their frequency is not known.

Geographic and Demographic Spread

The specific patterns of both malaria and typhoid fever are apparent across the range of geography and socioeconomic environments found in Nigeria. Malaria is endemic throughout the country, with higher prevalence in rural and peri-urban areas where mosquito control is poor [14].

Recent data suggest that rural regions in Nigeria report higher malaria prevalence (30–35%) compared to urban areas (15–20%), due to poorer vector control and limited access to health services. Similarly, typhoid fever is more prevalent in urban slums where sanitation infrastructure is weak [15].

High-risk rural population

Those at highest risk are poor rural populations with substandard housing quality, poor use of insecticide-treated nets, and poor adherence to prompt treatment. Typhoid fever is also endemic throughout the country and is very common in urban slums, with its attendant risks such as water contamination, open defecation, and poor waste management, increasing the risks of fecal-oral transmission [16].

Pregnant women and children continue to be the most affected groups. Pregnancy in areas where malaria is endemic confers heightened risk from immune modulation, and children with immature immunity are highly susceptible to both infections. Typhoid fever in childhood can cause systemic illness and complications if not diagnosed and treated early [17].

Exposure risk and health consequences are strongly influenced by socioeconomic status. People in low-income households are more likely to reside in areas that are favourable for disease transmission and have limited access to timely and quality healthcare due to their financial status. Low educational level may also influence knowledge and comprehension about the measures of prevention for diseases. And poor people have limited access to clean water and sewage, and good food, all of which are needed to stop cases of both the disease and typhoid fever [18].

Malaria and typhoid fever are still a high price to pay for public health in Nigeria, with overlapping patterns of epidemiology and disproportionate effects on the vulnerable population. The interplay of biological, environmental, and social factors underlies the difficulty in controlling these diseases and the requirement for specific interventions. To contextualize the public health significance of malaria and typhoid fever in Nigeria, Table 1 presents recent prevalence estimates from national and regional surveillance data.

Table 1: Prevalence Estimates of Malaria and Typhoid Fever in Nigeria by Region

Disease	National Prevalence (%)	Rural Areas (%)	Urban Areas (%)	Pregnant Women (%)	Children Under 5 (%)
Malaria	23.8%[1]	32.2%[2]	17.1%[2]	25–30%[3]	36%[3]
Typhoid Fever	~11–16%[4]	18–25%[5]	10–14%[5]	~12%[6]	~14%[6]

Note: Typhoid data are approximated from regional studies and WHO estimates due to lack of national surveillance

[1] Nigeria Demographic and Health Survey (NDHS), 2021 – [7]; [2] Olowolafe et al., 2024 – [14] [3] Bakken & Iversen, 2021 – [10]; [4] WHO regional surveillance estimates – [16], [63]; [5] Kim et al., 2023; Uwanibe et al., 2023 – [2], [12]; [6] Minwuyelet et al., 2025 – [17]

Diagnostic Enigma: Clinical and Laboratory Dilemma

Common Clinical Characteristics

This is due in part to the extensive symptom overlap between these two diseases, which is one of the major factors contributing to the difficulties in differentiating between malaria and typhoid fever in Nigeria. Symptoms of the two diseases are frequently present as nonspecific, including high-grade fever, headache, malaise, myalgia, and gastrointestinal symptoms, including nausea, vomiting, and abdominal pain [14]. Items are difficult to differentiate in the early stages of illness,

and, given the absence of laboratory confirmation, the symptoms may be difficult to diagnose by clinicians.

Malaria may begin with chills, sweats, and rigors, while typhoid fever has a more insidious onset of sustained fever, sometimes with constipation or diarrhea. Yet, these classic presentations are not often found in reality. Atypical, co-infections with other febrile diseases due to this syndrome will confuse clinical diagnosis in many patients. For pregnant women and children, who are unable to accurately report symptoms or who present with atypical symptoms, distinguishing between these diseases becomes even more difficult, and, as a result, patients are often misdiagnosed and overtreated [6]. The overlap of clinical symptoms of malaria and typhoid fever (Figure 1) is a significant factor in the difficulty of arriving at a diagnosis in febrile patients in Nigeria.

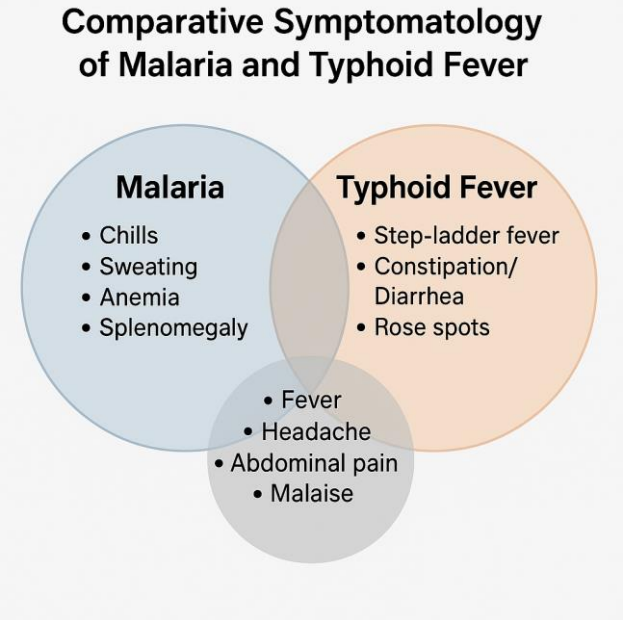

Figure 1. Comparative Symptomatology Between Malaria and Typhoid Fever.

The overlapping clinical features (e.g., fever, malaise, abdominal pain) contribute to diagnostic confusion in febrile patients. Distinctive signs such as chills (malaria) or rose spots (typhoid) are often under-recognized.
Source: Conceptualized by authors based on clinical literature [6, 14, 20].

Current Diagnostic Tools Fail to Fully Characterise Salmonella

Over 70% of typhoid diagnoses in public hospitals in Nigeria still rely on the Widal test, despite well-documented limitations [13]. Common diagnostic methods have certain deficiencies. Nigeria continues to practice suboptimal, accuracy and availability-driven diagnostic methods for both diseases, based on outdated technologies. Despite its numerous drawbacks, the Widal test is still widely applied for the diagnosis of typhoid fever in many healthcare facilities [19]. It detects agglutinating antibodies to Salmonella antigens, although cross-reaction, previous vaccination, and endemic exposure may give a false-positive result. Moreover, single Widal test results are of little diagnostic significance where there are no paired samples demonstrating rising titers [20].

Similarly, RDTs have enhanced access to diagnosing TB RDTs Malaria in rural and peripheral settings access to diagnosis in remote and peripheral settings, but are poorly sensitive in some situations. Some RDTs either miss low parasitemia levels or return false positives following recent treatment for malaria, owing to remaining circulating antigens [21]. Although microscopy (which is the gold standard for malaria diagnosis) is not readily available or of low quality in many primary health centers because of poor equipment and a lack of trained staff [22].

For typhoid fever, the gold standard for diagnostic confirmation, is bacterial culture, and in Nigeria, access to blood culture is constrained by cost, infrastructure, and turnaround time. Most of the centers are not equipped with adequate aseptic procedures, reagents, and well-trained microbiologists. These constraints make healthcare workers apply presumptive diagnosis, with them making clinical judgments rather than evidence-based ones [23].

Operational Approaches of Diagnosis in PHCS

Estimates suggest that more than **60%** of febrile illness cases in Nigeria are treated **empirically** without diagnostic confirmation [25]. Diagnostic practices are influenced by systemic barriers, such as limited funds, lack of diagnostic infrastructure, and skilled personnel, in primary care facilities in Nigeria. Health care workers working there often use syndromic case management, in which antibiotics are prescribed irrespective of whether there is laboratory confirmation, because treatment depends on the most likely clinical diagnosis. Although being pragmatic in resource-poor settings, such an approach induces an additional risk of misdiagnosis and treatment failure [24].

Cost and availability also come into play in diagnostic decision-making. Patients often have to pay for lab tests, and many can't. Here, patients (and treating physicians) may opt to diagnose with no option at all

and prematurely initiate therapy using symptoms alone. This leads to over-prescription of antimalarials and antibiotics, drives up drug resistance, and raises the cost of medical care [25].

Patent medicine vendors and informal pharmacies have a significant role in the provision of primary care in Nigeria. In many cases, these are non-emergency services and do not have access to blood testers or other methods of diagnosis. A large number of people provide medicine without a proper prescription or patient education, aggravating the cycle of inadequate and irregular treatment [26].

Difficulties in Verifying Co-infections

There has been a rise in the prevalence of malaria and typhoid co-infections over the years as reported in Nigeria, but most of these diagnoses are suspect owing to challenges of diagnostic specificity [6]. Genuine co-infections, in which both pathogens are simultaneously present and pathogenic, are observed in the real world, particularly in environments of common risk factors: low sanitation status and high risk of malaria infection. However, discriminating true co-infection from false positives in unreliable tests is still difficult [27].

While Widal tests false positives and persistent antigens in malaria RDTs could yield a potentially misleading co-infection diagnosis, leading to polypharmacy [28]. This not only exposes patients to side effects from many drugs, but also enhances the probability of the emergence of antimicrobial resistance, especially to antibiotics such as ciprofloxacin and third-generation cephalosporins [29]. In addition, co-infection diagnoses are seldom confirmed by gold-standard techniques such as blood culture and malaria microscopy, which are scarce in most health facilities.

Moreover, there are few descriptions of the clinical impact of co-infections, and what is known is incomplete. Due to a lack of validated algorithms for diagnostics and consistent treatment guidelines for suspected co-infections, healthcare providers are commonly provided with very little useful guidance, tending to overtreat [30]. Confusion with the diagnosis of both malaria and typhoid fever in Nigeria arises from symptom overlap, unreliable diagnostic tests, and poor health system support, with particular regard to rural and primary care facilities. This confusion leads to delayed or unwarranted care, particularly among pregnant women and children, and underscores the urgent need for better diagnostic capability and evidence-based clinical treatment [31]. To contextualize the diagnostic ambiguity between malaria and typhoid fever, Table 2 summarizes selected studies that report co-infection or misdiagnosis rates in Nigeria.

Table 2. Selected Studies on Malaria-Typhoid Co-Infection or Misdiagnosis in Nigeria

Study	Setting	Population	Diagnostic Method	Co-Infection or Misdiagnosis Rate	Remarks
Olowolafe et al., 2024[1]	Urban tertiary hospital	980 febrile patients	Widal + RDT	36% co-infection	Likely overestimated due to test limitations
Kuenzli & Neumayr, 2024[16]	Review	NA	Literature Review	~30–50%	Many diagnoses were clinically suspect
Ohanu et al., 2019[12]	Eastern Nigeria	402 patients	Widal vs. Culture	17% Widal+, 6% culture-confirmed	Widal lacked specificity
Odikamnoro et al., 2017[40]	Rural community	Adults	RDT + Widal	28%	Diagnostic accuracy was limited
Nakisuyi et al., 2023[10] (Uganda)	Regional comparison	Febrile children	RDT + Culture	12%	Included for SSA benchmark

Impact of Misdiagnosis and Late Treatment

Inappropriate Use of Antimicrobials and Antimalarials

Malaria and typhoid misdiagnosis often results in irrational use of antimalarials and antimicrobials, an action that has serious consequences for control efforts and public health [31]. There is a widespread unguided prescription of empiric antibiotics of fluoroquinolones, cephalosporins, and macrolides in Nigeria for febrile illnesses without confirmatory diagnostics, leading to an upsurge in AMR. On the other hand, the artemisinin-based combination therapy (ACT), the reference ther-

apy of malaria, is often given without parasitological diagnosis, leading to the risk of resistance to first-line anti-malarial drugs [29].

Other than the risk of non-adherence, unwarranted polypharmacy imposes an additional financial burden on already economically vulnerable families. The economic burden of administering multiple and frequently useless drugs (including laboratory investigations, re-consultations, and more days in the hospital because of treatment failure) can be catastrophic for families living below the poverty line. Additionally, the total pill burden increases the risk of non-adherence, poor therapeutic response, and pharmacological interaction, especially for pregnant women and children, who are more susceptible to the adverse drug effects.

The irrational use of antimicrobials also disturbs the microbiome, weakens the immune responses, and leads to a vicious circle of recurrent infections. In the absence of timely action to enhance diagnostic stewardship, this movement is poised to erode hard-won gains in the management of infectious diseases and further destabilize an emerging worldwide crisis of antimicrobial resistance [29].

The missed or delayed diagnosis of severe cases

Failure to diagnose and promptly treat severe malaria and typhoid fever greatly increases the hazard of fatal complications. In the case of malaria, particularly that caused by Plasmodium falciparum, failure to offer a diagnosis and treatment promptly can lead to cerebral malaria with fits, coma, and a high case mortality. Unrecognized malaria in pregnant women can lead to placental malaria, which affects the fetus nutritionally and oxygenally and contributes to poor pregnancy outcomes [32].

Typhoid fever, if poorly managed or misdiagnosed, may result in severe complications including intestinal hemorrhage, perforation, peritonitis, and septicemia. These are emergency conditions needing surgical treatment and intensive care, which are not accessible in rural, under-resourced regions [33]. Furthermore, since typhoid fever is an insidious infection, early misdiagnosis may lead to silent dissemination of infection to a point where therapeutic options are limited and the prognosis is grim. Such outcomes are especially tragic in resource-limited areas with minimal critical care capacity, where any delay in referral or transportation infrastructure may cause such deaths to be preventable [34].

Impact on Vulnerable Populations

Pregnant Women: Pregnancy induces immunological and physiological changes that increase a woman's susceptibility to infections and their complications. In the context of malaria, incomplete or delayed diagnosis and mistreatment can result in a cascade of adverse pregnancy outcomes, including miscarriage, intrauterine growth restriction, low birth weight, prematurity, and others. Notably, the sequestration of *Plasmodium falciparum* parasites in the placenta impairs maternal–fetal exchange, leading to placental insufficiency, chronic maternal anemia, and elevated risk of maternal mortality [35].

While typhoid fever during pregnancy is less frequently documented, it is equally serious. Severe bacteremia can result in septic abortion, preterm labor, and fetal loss. Moreover, maternal fever and systemic inflammation during critical periods of embryogenesis may disrupt organ development, potentially resulting in congenital anomalies and developmental delays[36].

These risks are particularly pronounced in resource-limited settings, where diagnostic tools are scarce, antenatal care is inconsistent, and emergency obstetric services are limited. Addressing diagnostic ambiguity is therefore essential for improving maternal health outcomes and achieving Sustainable Development Goals.

Children: The consequences of overdiagnosis and delayed treatment in children—especially those under five years of age—can be severe. Untreated malaria may rapidly progress to severe anemia, cerebral malaria, hypoglycemia, and death. Similarly, delayed diagnosis of typhoid fever can result in prolonged illness, dehydration, intestinal perforation, systemic sepsis, and high mortality among pediatric patients [37].

Beyond acute illness, recurrent or severe episodes of malaria and typhoid in early childhood can impair physical growth and neurocognitive development. In Nigeria, widespread childhood malnutrition exacerbates vulnerability to infections and hinders recovery, thereby perpetuating a vicious cycle of disease and developmental delay. The socioeconomic impact is substantial: long-term illness leads to parental work absenteeism, school dropouts, and increased healthcare costs—factors that contribute to intergenerational poverty [38]. The diagnostic overlap between malaria and typhoid fever is a significant factor in preventable deaths and long-term morbidity among Nigerian children. Early and accurate diagnosis remains vital for safeguarding child survival and development.

Characteristics of the Health Care System for Diagnostic Uncertainty

The diagnostic overlap between malaria and typhoid in Nigeria is more than a clinical conundrum; it is symptomatic of serious underlying weaknesses in the health system. Many health systems challenges— poor access to diagnostic resources, a lack of skilled human resources, and weak disease surveillance—converge to provide an environment conducive to misdiagnosis [39]. Resolving these issues is important for the development of interventions to increase the likelihood of diagnosing AF and reduce mortality in high-risk groups, including pregnant women and children.

Gaps in infrastructure and resources

One of the greatest challenges to accurate diagnosis is the gross insufficiency of laboratory infrastructure at health facilities in Nigeria. Most of the primary care settings do not have a functioning laboratory or are equipped with some basic diagnostic facilities, which are not updated and are poorly maintained. Stockouts of critical commodities such as malaria RDT, blood culture bottles, stains for microscopy, and even basic reagents are frequent as a result of poor procurement systems and unreliable supply chains. These limitations necessitate a heavy dependence on clinical diagnosis or substandard tests such as the Widal test, leading to a direct contribution to diagnostic uncertainty [40].

Another critical vulnerability is the referral system. In most rural areas, health service delivery is fragmented without a clear system and referral pathway for referral of difficult or non-diagnosed cases to a higher level of care. This fragmentation results in delays in confirming difficult diagnoses, such as typhoid fever, where blood culture is required, but generally not available at the first point of contact. Even for those who are referred, patients are frequently unable to travel to a centre either for financial reasons, distance, or simply because they are unaware of the possibility, and opportunities for accurate diagnosis and appropriate treatment are lost [41].

In addition, there is poor continuity among patients as there is no system for follow-up and patient tracing. Patients who are treated empirically in the absence of a confirmed diagnosis are rarely followed up to determine treatment response or complications, leading to cycles of empirical management and poor outcomes [42]. In northern Nigeria, for instance, many primary health centres lack on-site blood culture facilities and rely on patients traveling over 30 km for referral diagnostics—an often prohibitive distance due to cost and transport limitations [43].

Resource Human Constraints

Lack of trained health workers has been a common problem in Nigeria's health system for ages and an enabler of diagnostic confusion. The majority of health facilities are staffed with CHEWs or nurses with basic clinical diagnostic skills. There are few – if any – trained laboratory scientists or medical officers, particularly in rural and remote regions, which forces non-expert personnel to make important clinical decisions [44].

A deeper problem also lies in the absence of ongoing CPD and medical education. Diagnosis algorithms and treatment guidelines are not well communicated and updated periodically, and healthcare workers often work with outdated information and practices. This dearth in knowledge becomes particularly worrying in malaria and typhoid, where emergent resistance trends and revised diagnostic thresholds call for continuous training and oversight [44].

Without investments in human capital development, i.e., training, mentorship, and career incentives, the quality of diagnostic decision-making will continue to be suboptimal, compromising wider public health needs.

Lack of Data and Surveillance Gaps

Strong data systems are crucial for successful disease control, but Nigeria's health information systems are fragmented, hobbled by inconsistent and poor record-keeping. A lot of places are still using paper registers, with dubious or incomplete entries. The findings of laboratory tests, if any, are seldom found in patient records, impeding the benefit of decision-making or follow-up [45].

Malaria surveillance systems are relatively well-established thanks to consistent donor funding and attention at the global level, while typhoid fever is a neglected disease with limited incorporation into national surveillance. Sources of typhoid data are few, however, and we have no common scheme to monitor malaria-typhoid co-infections or diagnostic accuracy rates. This means policy decisions are made with incomplete epidemiological information, while health workers do not have a good sense of local disease trends to inform diagnosis and treatment [46].

By not having digital health systems that are integrated, real-time data sharing and coordination of care, and those feedback loops that are needed for quality improvement are lost. Unless there are investments in modernizing our record keeping using electronic medical records, regular data audits, and health information

training, the misdiagnosis of febrile diseases will continue to plague our system [45]. Health system challenges — inadequate infrastructure and supply problems, for example, as well as staff shortages and gaps in data and surveillance — provide a critical backdrop to the ongoing uncertainty over malaria and typhoid diagnoses. Enhancing these aspects is critical for obtaining an accurate diagnosis and better clinical outcomes, particularly in the case of higher-risk populations, including pregnant women and children [47]. As described in Figure 2, both system-wide and community-level challenges converge to produce a cycle of delayed diagnosis and treatment failure in the health environments of Nigeria.

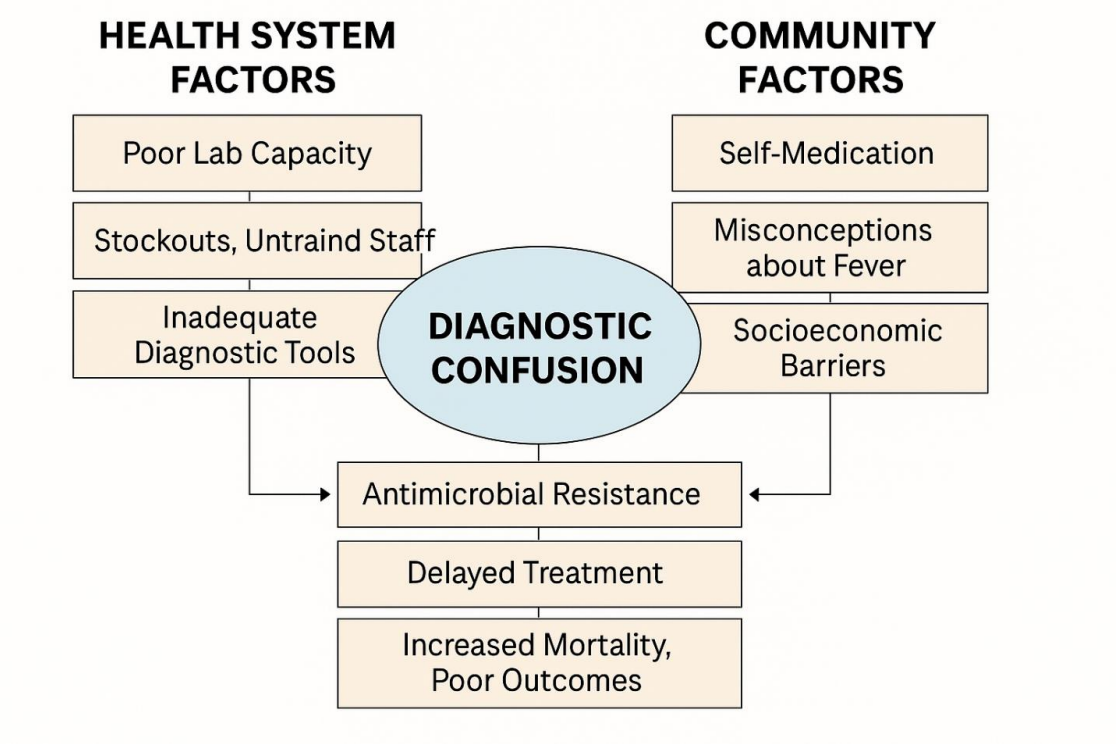

Figure 2: National and Community Drivers of Diagnostic Confusion in Nigeria.

This figure illustrates how health system factors (e.g., poor diagnostics, stockouts) and community behaviors (e.g., self-treatment, cultural beliefs) compound misdiagnosis. Adapted from Olowolafe et al., 2024 and Kuenzli & Neumayr, 2024 [14, 16].

Community Attitude, Care-seeking Practices, and Self-medication

In addition to clinical and health system challenges, community-level factors also drive patient misdiagnosis and mistreatment for Malaria and Typhoid fever in Nigeria. How people make sense of symptoms, respond to sickness, and navigate healthcare is influenced by a complex interplay of cultural beliefs, past experiences, and the reality of their social circumstances. The delay in correct diagnosis, due to these factors, promotes inappropriate treatment, especially in vulnerable populations such as pregnant women and children [48].

Erroneous Popular Beliefs and Practices about Fever

Febrile episodes are not commonly considered in many Nigerian societies as a sign of can entail different possible disease; rather, it is treated as one specific disease, frequently identified nonspecifically as “malaria” or “typhoid.” Cultural beliefs and rudimentary biological knowledge tend to reinforce the idea that it has to be one or the other of the two. This results in self-diagnosis and self-medication, often empirically, and without laboratory testing. Malaria is often a slight occurrence, and diagnosis by observation is difficult.' The case in point has done more to keep up the impression than all the others in that decade.'The term "malaria" is used very loosely as a blanket term to describe what is often nothing more than an unexplained illness, and where treatment for malaria has failed, "Typhoid" is often the diagnosis, to complicate an already difficult diagnosis.

Moreover, supernatural, spirit-caused, and folk perceptions of illness (e.g., bewitchment or body "overheating") continue to have a great influence in numerous farming areas. Such beliefs may cause delayed presentation to formal healthcare facilities and the application of herbal or spiritual treatments before formal medical consultation, thus increasing the likelihood of untreated infection and its complications.

Previous Experiences and Community Norms

The experiences of the sick and the healing strongly shape the health-seeking behaviour of both individual and collective persons. Anecdotal knowledge or previous experiences frequently inform families' treatment decisions [49]. For instance, in case one, the child had recovered from febrile sickness through a given drug in the past, a caregiver may repeat the same treatment without consulting health workers, irrespective of the cause of the new febrile sickness.

Diagnostic beliefs are also influenced by peer pressure and community norms. Citizens widely trade prescriptions, diagnostic assessments, and treatment hacks, building a shadow network of information that runs apart from the state. Such dependency on the community knowledge source, however, may reinforce diagnostic assumptions and impede the proper utilization of health care services.

Pharmacies and Patent medicine vendors are at the core

The abundance of pharmacies and patent medicine vendors (PMVs) in Nigeria is an avenue for easy accessibility of drugs but encourages unsuitable self-medication. These types of vendors, often working without any medical training, are in many settings the first port of call for febrile patients, particularly in resource-limited areas. And they often prescribe antimalarials, antibiotics, or even combinations of the above based solely on a patient's reported symptoms, without conducting diagnostics [26]. Although they bridge the gap in healthcare access, their practice biases towards misdiagnosis, polypharmacy, and antimicrobial resistance. Furthermore, they erode trust towards official health systems, while patients may prefer the apparent convenience and affordability of PMVs over professional advice.

Influence of Sociodemographic Status on Health Care Seeking Behaviors

Socioeconomic issues profoundly determine how people react to illness. The direct out-of-pocket (OOP) expenses required for outpatient healthcare services such as consultation fees, diagnostics, transport, and drugs are too expensive for most families in Nigeria, especially in rural and peri-urban regions. In these cases, self-medication tends to be a rational decision as patients cannot afford to pay for professional treatment [50].

Poor health literacy, poor access to decent healthcare services, and financial insecurity all combine to create an environment where diagnostic ambiguity is not scuppered by systemic inadequacies alone but also flourishes in the fact of people who cannot afford to know what is wrong with them. Consequently, individuals who are most at risk of presenting with treatment delays and poor health outcomes, such as pregnant women and children, are left exposed [51].

Areas for improvement and recommendations

Addressing the diagnostic overlap between malaria and typhoid fever in Nigeria requires targeted, practical strategies that involve all levels of the healthcare ecosystem. These recommendations are structured to guide key actors—health authorities, frontline providers, community leaders, and regulatory bodies—in implementing feasible, context-specific interventions. The goal is to reduce misdiagnosis, improve treatment accuracy, and protect vulnerable populations, especially pregnant women and children [52].

Diagnostic Improvements (Led by: Federal Ministry of Health, Diagnostic Partners)

- Adopt and deploy improved rapid tests for malaria and typhoid with higher specificity, especially dual-antigen malaria RDTs and validated typhoid antigen tests suitable for field use [53].
- Promote integrated diagnostic platforms, such as multiplex tests, capable of identifying multiple febrile illnesses from a single sample [54].
- Prioritize point-of-care diagnostic access in rural and under-resourced areas through mobile labs or decentralized testing hubs [55].
- Establish national evaluation and procurement guidelines for diagnostic tools to ensure reliability and reduce use of unvalidated tests like the Widal [56].

Strengthening Frontline Care (Led by: State Ministries of Health, Primary Healthcare Agencies)

- Train primary care providers and laboratory staff on up-to-date diagnostic protocols for malaria and typhoid, including interpretation of RDTs and when to refer for confirmatory testing [57].
- Integrate malaria and typhoid case management into standardized fever algorithms, supported by decision-support tools like flowcharts adapted for pregnant women and children [58].
- Improve health facility readiness by ensuring consistent availability of RDT kits, basic microscopy supplies, and transport logistics for specimen referral.
- Introduce structured diagnostic checklists in primary health centres to guide symptom-based differentiation and reduce reliance on empirical treatment. Figure 3 illustrates a context-adapted diagnostic and treatment algorithm that may guide clinical decision-making during febrile illness, especially in resource-limited settings [59].

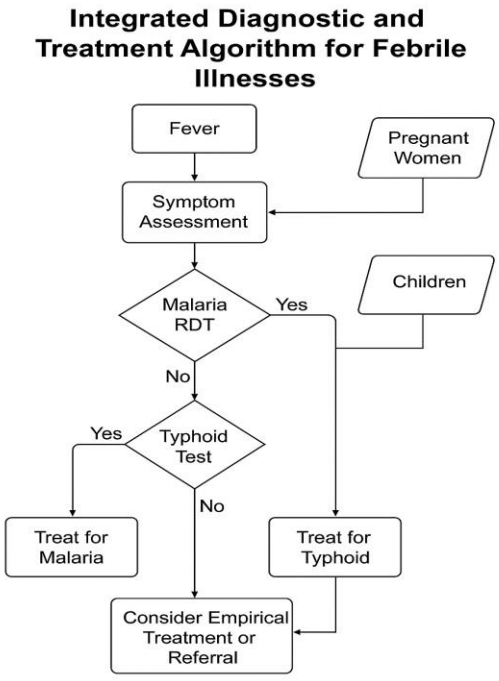

Figure 3: Integrated Clinical Decision Flow Chart for Febrile Illness in Resource-Poor Settings. Designed for use in PHCs to aid diagnosis and treatment of malaria and typhoid, especially among pregnant women and children. *Adapted from WHO malaria diagnostic flowcharts and context-specific protocols [7, 58]*

Community-Level Interventions (Led by: Community Health Workers, NGOs, Traditional Leaders)

- Conduct targeted health education campaigns to correct misconceptions (e.g., "all fever is malaria or typhoid") and promote early presentation to health facilities.
- Empower community health workers (CHWs) to act as diagnostic liaisons—assisting with RDT use, referrals, and follow-up in hard-to-reach areas [60].
- Discourage self-medication and polypharmacy by promoting awareness of diagnostic testing before treatment through radio, religious gatherings, and peer groups.
- Foster community engagement around water safety and hygiene to reduce the risk of typhoid transmission [61].

Policy and Regulatory Action (Led by: NAFDAC, NHIA, Legislators)

- Enforce stricter regulation of diagnostic and pharmaceutical practices, including restricting Widal test use without confirmatory protocols and curbing over-the-counter antibiotic sales.
- Develop and distribute national guidelines on febrile illness diagnosis and treatment, tailored to different facility levels and translated into local languages [62].
- Expand diagnostic coverage under the National Health Insurance Scheme (NHIS) to reduce out-of-pocket costs and disincentivize presumptive treatment.
- Scale up investment in WASH infrastructure in typhoid-endemic areas, focusing on safe water supply, sanitation, and food safety enforcement [63].

Conclusion

The recurrent misdiagnosis of malaria and typhoid fever in Nigeria is a prevailing public health crisis with serious public health implications. The two diseases have similar clinical manifestations and affect the same geographical and social circumstances, as a result of which they are often misdiagnosed. The consequences of the diagnostic uncertainty are especially dire for a pregnant woman and a child, as these populations are already heavily burdened by diseases but are more vulnerable than others to the negative effects of a delayed or inappropriate management [64].

As the review indicates, the impact of diagnostic uncertainty is compounding: inappropriate antimicrobial application drives resistance, life-threatening sequelae result from untreated infection, and financial investments in therapies that are ineffective are wasted. These results are compounded by health system bottlenecks, including weak laboratory infrastructure, inadequate capacity for health-worker training, and suboptimal surveillance. In addition, issues at the community level, such as cultural attitudes, self-medication, and financial constraints, inter alia, further add to the delay in, and inadequate, care.

Solving this issue would take a system-wide effort. Advances in diagnosis, particularly the point-of-care diagnostics suited to low-resource settings, need to be combined with investments in healthcare workforce development, integrated disease management strategies, and community-level education. There should be a policy that encourages the regulation of diagnostics and pharmaceuticals, and promotes infrastructure in clean water and sanitation in order to prevent the occurrence of typhoid.

More research will be required to justify the resources needed to verify context-specific diagnostic approaches and understand local epidemiologic trends [65]. A similar policy alignment and political will will be necessary at the national and subnational levels to maintain the gains. In the end, disentangling diagnostic uncertainty is not just a clinical necessity, but a moral one: The best way to conquer avoidable disease and death among Nigeria's most vulnerable people.

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Original Article

Understanding the Rising Trend of Medical Exemptions in Childhood Vaccination: A Qualitative Study of Healthcare Providers' Perspectives in Kazakhstan

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Abstract:

Background: Vaccination is one of the most effective public health interventions yet increasing numbers of unjustified medical exemptions in Kazakhstan threaten both herd immunity and public trust. In 2020 alone, over 208,000 temporary and 2,600 permanent exemptions were issued—often based on questionable clinical criteria. This study aims to explore the drivers behind the rising number of medical exemptions in Kazakhstan, with a particular focus on the perspectives and attitudes of healthcare professionals.

Methods: A qualitative approach was employed, combining a desk review of national immunization policies and statistical reports with 27 in-depth interviews conducted in 2021–2022. Participants included healthcare providers and public health experts across urban and rural regions of Kazakhstan. Thematic analysis was used to identify key patterns in the data. Relevant national regulations were also reviewed and compared with international standards.

Results: Thematic analysis revealed four major areas of concern: (1) inconsistencies in pre-vaccination monitoring practices, (2) variability in post-vaccination follow-up procedures, (3) divergent roles and responsibilities among stakeholders in granting medical exemptions, and (4) limitations in surveillance and data systems for tracking and verifying exemptions. Findings suggest that physician over-cautiousness, legal insecurity, parental pressure, and inconsistent training are key drivers of unnecessary exemptions. The over-diagnosis of precautionary conditions—particularly by specialists such as neurologists—further contributes to false contraindications. These practices erode vaccine confidence and create barriers to timely immunization.

Conclusion: Addressing the growing problem of unwarranted medical exemptions requires policy reform, clearer clinical guidelines, enhanced physician training, and improved digital monitoring systems. Strengthening these areas is essential for restoring public trust, reducing unjustified exemptions, and ensuring high vaccination coverage in Kazakhstan.

Keywords: Kazakhstan; vaccination; medical exemptions; vaccine hesitancy; immunization policy; health systems

Introduction

Vaccination is one of the most effective public health interventions, preventing millions of deaths annually from vaccine-preventable diseases (VPDs). According to the World Health Organization (WHO), global immunization coverage has contributed significantly to reductions in childhood morbidity and mortality (1). Kazakhstan has maintained high routine vaccination coverage, with over 95% of children receiving vaccines in accordance with the National Immunization Schedule (2). Despite these efforts, there are certain difficulties in the attitude of both parents and health care providers towards the process of vaccination of children. Despite this strong coverage, outbreaks of diseases such as measles in 2005 and 2019 suggest that reported coverage may not reflect the actual population immunity. In 2019 alone, more than 13,000 measles cases were recorded, with a substantial proportion among unvaccinated children (3). These gaps are partly attributed to increasing numbers of medical exemptions from vaccination, many of which may be clinically unjustified.

While valid medical exemptions are essential for protecting vulnerable individuals, unjustified or excessive exemptions undermine herd immunity. International evidence suggests that such exemptions often reflect provider hesitancy, legal fears, or misinterpretation of contraindications rather than actual medical need. For instance, after the removal of non-medical exemptions in California, the number of medical exemptions increased disproportionately, contributing to new Vaccine-preventable disease (VPD) outbreaks (4). Similarly, there was an increase in the number of medical exclusions (MIs) following the cancelling of non-medical exclusions (NMIs) in Australia (5).

In Kazakhstan, data from the Ministry of Health (MoH) indicate a concerning trend: 208,932 temporary and 2,642 permanent medical exemptions were issued in 2020. Yet international guidelines suggest true contraindications affect fewer than 1% of children (6). Studies in similar settings have found that healthcare providers may issue exemptions out of caution, under parental pressure, or due to knowledge gaps (7, 8).

As global data shows, vaccine hesitancy may contribute to low vaccine acceptance (9). The growing role of healthcare providers in facilitating exemptions requires urgent attention, particularly in the context of vaccine hesitancy. Nowadays, the issue of vaccine hesitancy is widely recognized and has been detected in more than 90% of the countries globally (10). The WHO has identified vaccine hesitancy as one of the top ten threats to global health (11, 12). About 22,291 children in Kazakhstan have missed vaccinations in 2020 due to parental refusals (13). Nevertheless, anti-vaccination attitudes among parents are not the main reason for incomplete vaccination coverage. UNICEF emphasizes that health workers are key influencers of parents' vaccination decisions (14). Their beliefs and practices can both encourage and discourage vaccination. Lack of awareness among health workers about contraindications to vaccination and the impact of misinformation can lead to unjustified medical exemptions or false vaccine contraindications (FVC) (15, 16). Since healthcare professionals' (HCPs) knowledge and attitudes have a significant impact on patients' decisions to vaccinate, enhancing their confidence in vaccination through targeted education and reliable information plays a crucial role (17).

Globally, countries have implemented standardized systems to monitor and respond to adverse events following immunization (AEFIs), including digital registries and dual-reporting mechanisms involving both healthcare providers and recipients. Prompt identification and reporting of adverse drug and vaccine reactions are essential to successful case investigation (18). In contrast, Kazakhstan's reporting remains fragmented, with data collected manually and lacking detail on exemption duration or justification. Study conducted by Hodel et al. (2024) emphasizes that underreporting of adverse events is a significant challenge in pharmacovigilance, with studies estimating that over 90% of adverse events go unreported by healthcare professionals (19).

While research in Kazakhstan has largely focused on parental vaccine refusal and hesitancy, limited qualitative work has been conducted on healthcare provider perspectives. Understanding provider decision-making, knowledge gaps, and perceived systemic barriers is critical to formulating effective policy interventions. This study aims to explore the drivers behind the rising number of medical exemptions in Kazakhstan and assess the robustness of the AEFI monitoring system. By capturing the perspectives of healthcare professionals and examining existing processes, the study seeks to identify gaps in policy, practice, and data infrastructure that affect immunization coverage.

Methods

The study used a qualitative design combining desk research. The desk review covered Kazakhstan's national immunization policies, regulations, and health system data regarding vaccination process and AEFI monitoring. The qualitative component examined healthcare providers' lived experiences with issuing medical exemptions and monitoring AEFIs.

The study was conducted across various regions of Kazakhstan, including urban and rural healthcare facilities which provide childhood immunization services. Participants were recruited from primary healthcare centers, pediatric clinics, and immunization units throughout different regions of the country to reflect geographic and institutional diversity. A purposive and snowball sampling strategies had been employed to include participants with direct experience in vaccination decision-making: (a) medical practitioners, (b) health management representatives, (c) public health experts. Inclusion criteria for participants encompassed healthcare professionals directly involved in the organization or delivery of childhood immunization services, such as pediatricians, general practitioners, nurses responsible for administering vaccines in polyclinics, and immunization program coordinators at the facility or regional level. The selection of these groups of professionals was guided by the objective to gain a comprehensive and multi-level understanding of the practices related to unjustified medical exemptions and the registration of AEFI within the childhood vaccination system in Kazakhstan.

Semi-structured, in-depth interviews were conducted to collect the data. Interviews had been conducted both face-to-face and via online video calls when in-person meetings were not feasible. The interview guide was developed by the research team based on a comprehensive review of the relevant literature. Key topics included: (a) healthcare providers' decision-making processes regarding medical exemptions, (b) perceived barriers and challenges in vaccination policy implementation, (c) the role of AEFI monitoring systems in vaccine coverage analysis. The interview questions covered procedures ad reasons for granting medical exemptions, use of clinical guidelines, communication with parents, challenges in data systems and suggestions for improving current practices. Interview guides are available in the supplementary materials for reference. Audio recordings of the interviews were transcribed. Each interview lasted about 60 minutes on average. Interviews were conducted in Kazakh and Russian, and translated into English for analysis.

Thematic analysis approach was applied using open coding to identify emerging patterns and categories (20). Comparative review of Kazakhstan's policies with international best practices (WHO, CDC) was applied. Two researchers independently reviewed the transcripts, and discrepancies were resolved through consensus. Coding was conducted manually. An analysis of business processes at medical organizations was conducted to assess gaps in the registration and monitoring system. Verbal informed consent was obtained from all participants before the interviews. Confidentiality of the data and anonymity of the identity of the participants were ensured. Participants were given the option to withdraw from the study at any stage. This study was reviewed by the Research Center "Paperlab" and was deemed exempt from full ethical review (N43-21).

Results

During the period from November 2021 to February 2022, we interviewed 27 participants from nine regions of Kazakhstan, including (a) medical practitioners, (b) health management representatives, (c) public health experts (Table 1).

The data analysis is structured by categorizing the vaccination process and the recording of medically ineligible persons and AEFI around four key thematic areas: (1) Inconsistencies in Pre-vaccination monitoring practices; (2) Variability in post-vaccination monitoring; (3) Divergent roles and responsibilities among stakeholders in granting medical exemptions; and (4) Surveillance and data systems limitations in monitoring medical exemptions.

Inconsistencies in Pre-vaccination monitoring Practices in Kazakhstan

This step involves the patient and physician interacting before the patient is admitted for vaccination. Before the medical examination, the doctor should talk to the parent about the principles of risk-benefit weighing when deciding whether to vaccinate. If the parent is ready to vaccinate their child, an informed consent is filled out in the form specified in the Sanitary Rules "Sanitary and Epidemiological Requirements for Prophylactic Vaccination of the Population".

Table 1. Study sampling of 27 participants by city and participant groups

Characteristics	
Study participants, by city and professional role (n=27)	
Astana city	9
Public health experts	5
Health management representatives	2
Medical practitioners	2
Almaty city	4
Public health experts	2
Health management representatives	1
Medical practitioners	1
Shymkent city	1
Medical practitioners	1
Almaty region	4
Health management representatives	1
Medical practitioners	3
Karagandy region	4
Health management representatives	1
Medical practitioners	2
Pavlodar region	2
Medical practitioners	2
Atyrau region	1
Health management representatives	1
Zhambyl region	1
Medical practitioners	1
Kyzylorda region	1
Health management representatives	1
Participant groups, by professional role	
Public health experts (n=7)	
Health management representatives (n=7)	
Medical practitioners (n=13)	
Pediatric neurologist	5
Pediatrician	2
General practitioner	1
Vaccination nurse	3
Immunization doctor	1
Infectious disease specialist	1

Informants had different accounts of the order of examination and informed consent. Some interviewees said that the informed consent is signed before the examination (as the content of the document implies), while others said that the examination is conducted first, and then they are told about the vaccination and asked to sign the consent. It is likely that in the second case the respondent was describing the combination of admission to vaccination and age-appropriate preventive examinations. Scheduled vaccination is included in the process of child health monitoring and is predominantly carried out on the days of preventive examinations (or on the nearest vaccination day after them).

The subject of professional training of doctors on vaccination is beyond the scope of this study, but it should be noted that the curricula of pre-graduate, postgraduate and additional medical education do not ensure the continuity of transfer and accumulation of advanced knowledge on immunization by medical workers. Thus, standard professional curricula for medical and pharmaceutical specialties define a list of the most common diseases and conditions to be diagnosed and treated. At the same time, according to the modules of curricula for medical specialties of residency, mandatory study of vaccination is required only for the following specialties: family medicine, neurology, pediatrics, and infection.

In terms of theoretical knowledge of Kazakhstani medical students, the situation is not the best: the degree of their awareness of vaccination is assessed as below average, and students have an inherent belief in vaccination myths (21). It is also important that the modules of training programs do not provide requirements for mastering certain practical skills, manipulations, procedures of work on immunization, including the appointment of medical exemptions and AEFI.

Hence, the study indicates significant variability in how pre-vaccination screening is conducted. Some physicians require parents to sign informed consent before screening, while others conduct medical examinations first. A common issue is a lack of standardized communication about vaccine safety, which fosters parental concerns. Healthcare providers in Kazakhstan conduct pre-vaccination assessments, but variability exists in the application of medical exemption criteria. Physicians are often cautious due to fear of legal consequences if an adverse event occurs, parental pressure to issue exemptions, and lack of standardized training on vaccine contraindications.

Variability in post-vaccination monitoring

For the next three days after inactivated vaccine administration and on days 5-6 and 10-11 after live vaccine administration, the district nurse provides post-vaccination follow-up at home. As health workers explained, most often they communicate with the parent

of the vaccinated child via telephone or online messengers; if this is not possible, they make home visits.

"The nurse calls or goes home and asks if there was a fever the next day, if there was any reaction, rash or what, how the child behaved. This asset is documented in Damumed" – [district pediatrician, Almaty Oblast].

Citing high workload, some of the interviewees reported that they do not call their patients but carefully instruct them in which cases they should definitely seek medical help (red flags).

In practice, not all the steps are followed, and adherence to the procedures depends on the management of the primary healthcare organization (PHC) and the workload of health workers. For example, nurses may not provide post-vaccination follow-up, sending the child and parents home immediately after vaccination. Also, health care workers may not always provide home-based follow-up, expecting patients to be able to make contact if they develop distressing symptoms.

Divergent roles and responsibilities among stakeholders in granting medical withdrawals

The provision of medical withdrawals is regulated by the Order of the Ministry of Health of the Republic of Kazakhstan from October 21, 2020, №RK DSM-146/2020 "On approval of the list of medical contraindications to prophylactic vaccinations". The order defines general permanent and temporary contraindications, as well as permanent and temporary contraindications to live vaccines and certain types of vaccines.

According to the existing regulations in Kazakhstan, a district pediatrician or general practitioner cannot independently grant a child a medical exemption of more than one month. For granting a permanent medical excuse, the conclusion of the Medical Advisory Committee at PHC organization is required. However, with regard to long-term temporary medical exemption, in some PHC organizations, the opinion of a specialist with a recommendation to postpone immunization is sufficient, while in others, the medical exemption requires the opinion of the Medical advisory committee. This leads to differences between health care organizations in the number of medical appointments and children's delay in the immunization calendar.

Interviews show that the practice of medical withdrawal is widespread. One of the nurses interviewed reported that at her site, every second child aged 1-2 months is recommended by a neurologist to be medically withdrawn for 2-4 months. At the same time, one of the interviewed neurologists reported a similar view.

"Almost always, in 99.9%, there are no contraindications on the part of the nervous system, and the vaccine that we use in Kazakhstan, even if there is some neurological condition, can be administered" – [pediatric neurologist, Astana].

Physicians themselves find it difficult to give an accurate assessment of the commonness of medical exemptions without valid justification. Thus, when asked about the possible share of unfounded medical exemptions, the answers of respondents varied from 20 to 50% of temporary medical exemptions. One of the neurologists interviewed admits that 90% of medical exemptions are false.

"If a child came for an appointment at the polyclinic, it is a child who can be vaccinated if his/her somatic status allows it, i.e. no fever, no diarrhoea, clearly compensated condition, because he/she is at home and not in intensive care" – [pediatric neurologist, Astana].

When discussing the reasons for medical exemptions, based on false contraindications, most respondents noted that doctors prescribe medical exemptions in order not to take responsibility for possible negative consequences of vaccination. Informants attributed the lack of confidence in the safety of vaccinations to the insufficient level of qualification of doctors and their legal insecurity:

"We have such legislation in our country, such an attitude towards doctors, when they are always looking for a scapegoat if something goes wrong after vaccination" – [pediatric neurologist, Shymkent].

As reported by the participant, this is especially true for neurologists who do not allow children to be vaccinated, citing *"delayed psychomotor development"*, *"perinatal encephalopathy"* and *"intracranial hypertension"*. Postponing vaccination due to false contraindications is also an option when dealing with parents who doubt the safety of vaccinations. More often parents ask to postpone the start of vaccination for 1-2 months, such behavior is attributed by interviewees to lack of confidence in the safety of vaccinations.

Pediatricians report that every fifth parent asks for a medical excuse, and one neurologist reported that up to 50% of his patients ask for a medical excuse. Thus, a significant proportion of temporary medical exemptions may mask refusals to vaccinate, as refusals are subject to special oversight by regulatory agencies.

The assumption that unjustified medical exemptions might be linked to vaccine supply challenges was not supported by participant accounts. Respondents consistently reported no observed shortages of vaccines in their practice.

"We already have everything calculated, we have all the vaccines, we have everything, and everyone has enough. [We just have to] have the patient show up at the polyclinic and have the patient examined" – [general practitioner, Almaty].

The interviews revealed a wide range of diagnoses that are used by doctors to prescribe not only temporary but also permanent medical withdrawals. Thus, medical exemptions are granted to patients with atopic dermatitis (even in remission), bronchial asthma, arthritis, chronic bronchitis, autism and Down syndrome. Despite the clear list of reasons for medical exemptions, in practice, their granting is largely subjective, and neurologists may differ in their assessment of the risks of vaccination for certain conditions. For example, one of the interviewed neurologists named epilepsy and seizures as grounds for permanent medical withdrawal. According to two other neurologists, medical withdrawals are not necessary for epilepsy, cerebral palsy, seizure syndrome successfully controlled by medications.

"Before getting a vaccination, he does not have to go to a neurologist, it is our pediatricians who send him, and so he only needs a somatic status, the neurological status has no effect on whether he needs to be vaccinated or not. I don't quite understand why they send them to see a neurologist" – [pediatric neurologist, Astana].

The study displayed that PHC organizations can effectively tackle the practice of unjustified medical refusals at their level. The tools include both peer decision-making in doubtful cases (CDC) and direct management control. The motivation for such action is the commitment of those in charge to immunization.

"[...] And so she was an anti-vaxxer. [...] If, for example, a child's mother said she didn't want to receive the vaccine, the doctor would agree and write a medical exemption. I decided for myself that I would no longer work with her, because this system of work does not correspond to my principles. It turns out that eight out of ten patients left with a medical excuse. This is a drawback for my institution and contradicts my principles" – [health management representative, Almaty Oblast].

Since it is the pediatrician or general practitioner who determines admission to vaccination, specialists can recommend medical withdrawal, but the final decision rests with the district GP. However, as informants noted, even if the pediatrician understands that he or she has encountered overdiagnosis, the district doctor will not go against the conclusion of the specialist.

The question of the impact of medical exemptions on parental trust in vaccination remains unresolved. On the one hand, parents can interpret the appointment of a temporary medical excuse as an individual approach to the child's health. This will increase trust in the doctor and in immunoprevention, as the parent will be sure that the doctor is attentive to the child's condition. On the other hand, frequent medical exemptions may be seen as a signal that immunization is unsafe, especially when medical exemptions are given to healthy children.

One of the immunization specialists interviewed said that in his practice, half of the parents of children with long medical withdrawals refuse immunizations after the medical withdrawal is lifted:

"She already thinks that if she has a medical excuse, 'I will wait until the child is three years old,' and then they will wait until the child is six years old, until the child goes to school, and then they start to have this busy time, they come, like this year, we have a lot of six-year-olds coming" – [immunization doctor, Pavlodar Oblast].

From the interviews conducted, reasons for FME were mentioned by participants: (1) Fear of legal repercussions for adverse effects following immunization (AEFI); (2) Lack of physician confidence in vaccine safety, (3) Overdiagnosis of conditions like "perinatal encephalopathy" and "intracranial hypertension"; (4) Pressure from vaccine-hesitant parents requesting exemptions.

Surveillance and data systems limitations in monitoring medical exemptions

The number of medical refusals is reflected in site reports on the implementation of the vaccination program, where temporary and permanent medical refusals are considered separately, but their timing and reasons are not noted (Form No. 4 "Report on Preventive Immunization Coverage"). Reports from the districts are manually summarized by department or by the PHC organization as a whole and sent to the regional epidemiologists of the Department of the Sanitary-Epidemiological Control Committee (DSECC) for collection, processing and analysis.

"We have five district departments, they submit the third and fourth forms to the immunologist and infectious disease specialist, and the latter enter them into a pile in the computer" – [general practitioner, Astana].

All data on the qualitative characteristics of the prescribed medical exemptions remain at the PHC organization level, and monitoring is done by the district service.

"In Damu KMIS [...] it is personalized for each child" – [health management representative, Astana].

The existing approaches to recording medical withdrawals, when no information is collected on timing and diagnoses, do not allow DSECC to conduct any analysis other than estimating their number. Statistics do not even reflect the share of children who have received medical appointments, as each medical appointment is recorded as a separate fact, and a child may receive several medical appointments for different reasons and for different periods during the year. The content of Form No. 4 is not verified by data from information systems (KMIS), which creates opportunities for manipulation of statistics. It is possible to verify the reliability of data on medical refusals only when working with preventive vaccination cards and outpatient records of patients:

"Whether they have vaccinated all the planned children, this is what our epidemiologists check in the places. If a child has not been vaccinated for one reason or another, I mean, if it is a medical exemption, then we look at the journal, if they recorded it, then the child has not left the field of attention, they are aware that the child should be vaccinated but has not been vaccinated for certain reasons" – [health management representative, Kyzylorda Oblast].

At the same time, data on medical exclusions are collected in KMIS, but they are used only at the level of PHC organizations. There is no external verification of the data collected on the reasons for medical withdrawals.

"There is no analysis, no request for data on these children, for what reasons the medical withdrawal was issued, we do not provide this information to anyone" – [health management representative, Astana].

Since data collection is not automated, DSECC staff continue to manually summarize data from reporting form No. 4, and the lack of information on the reasons for and duration of medical appointments does not allow for analysis and managing this process.

"I don't know what diagnoses there are, whether they are really permanent, who is involved there - we don't see either. It can be children under a year old, for example, or children who have been registered for a long time, it can be cumulative, in these 400 [permanent medical exemptions] there are children up to 16 years old who are on dispensary registration as a permanent medical exemption" – [public health experts, Astana].

Analysis of the reasons for medical refusals can currently be carried out only at the level of Health Departments, but such work requires significant labor input.

"As a rule, each Health Department has out-of-department pediatricians, immunologists. They already do, well, at least they should do - in the regions I do not know how much and how this work is done - analyze these medical withdrawals and look at the validity of these medical withdrawals and already work directly with district pediatricians, neurologists, etc." – [public health experts, Almaty).

During the interview, the opinion was expressed that data on the reasons for medical withdrawals should not be sent somewhere else from the medical organization that needs it to ensure immunization coverage.

"To be sent, for what purpose? Just to understand what medical withdrawals? I understand if that medical refusal was further discussed, but that's not there. [...] But I think this data should not go somewhere, I think it is the responsibility of each organization, each district GP, if he has such an indicator, if he is interested in this" – [health management representative, Astana].

The participants responded that DSECC's access to preventive vaccination card data and outpatient records will enable the development and management of an automated system to monitor and control the administration of medical withdrawals from routine immunizations to reduce the number of unwarranted medical withdrawals and vaccination schedule backlogs.

"I can see improvements for myself only when the system will work. Because we would like to see not only dry fig-

ures on medical refusals, there are 5 thousand medical refusals somewhere in the region, but what kind of medical refusals they are. [...] For 7-8 years we have been trying to create such an information system" – [public health experts, Astana].

Health workers' doubts about the safety of immunization are also related to the realization that AEFI are not properly recorded, and the quality of vaccines cannot be controlled. In the current context, most serious AEFI are isolated, and regulators lack information to systematically analyze the safety of vaccination.

There was also reported a conflict of interest where only health workers can report AEFI. An exception is the reporting of adverse events after BCG vaccination. Due to the unfavorable epidemiological situation of tuberculosis in the country, possible AEFI are perceived as an inevitable evil, tolerance to them is higher. The procedure for responding to AEFI after BCG is different, in particular, emergency notification to the Sanitary-Epidemiological Control Committee (SECC) is required only when group cases are detected. Single reactions are registered, the child receives important observation and treatment, but there is no intervention of regulatory authorities.

It was clear that although PHC organizations monitor exempted children at the local level, the absence of standardized data integration with regional health authorities (DSECC) prevents effective oversight and strategic planning. Manual data processing further complicates efforts to track trends and assess the validity of exemptions, leaving room for inconsistencies and potential manipulation. Without an automated system for monitoring exemptions, public health experts emphasize that improving immunization coverage and reducing unwarranted exemptions remains a significant challenge. Developing a comprehensive, centralized database could enhance the management of medical withdrawals, facilitate data verification, and ultimately strengthen Kazakhstan's vaccination program

Discussion

This study highlights the role of unjustified medical exemptions in increasing immunization rates in Kazakhstan, i.e. it can reduce vaccine coverage and contributes to preventable outbreaks which aligns with other studies (15, 16). The procedures and order of medical exemption appointment differs between individual PHC organizations. The application of the norms of the regulatory documents on medical exemption in practice depends on the management in a particular medical organization, human resources and their qualifications. Thus, the current regulations set only a general framework for the appointment and registration of medical withdrawals in Kazakhstan.

Our participants described barriers to the public perception of the safety of immunization. The study revealed the problem of uninformed and poorly trained physicians themselves in immunization, echoing broader concerns about health literacy and institutional readiness in Kazakhstan's health system (22). The overuse of unjustified medical exemptions is often driven by physicians' misconceptions about vaccine safety and overestimation of parental concerns in regard to immunization (8, 23). Physicians' reluctance to take responsibility for vaccine reactions also contributes to unnecessary medical exemptions. According to the interviewees, many specialists tend to overestimate the risks of vaccination, prescribing excessive laboratory tests or prophylactic use of antihistamines and immunomodulators. Such excessive caution on the part of health care providers does not help to increase confidence in vaccinations (24). For example, one of the neurologists interviewed strictly recommends that parents "get tested before vaccinations" to avoid negative consequences of vaccination (in this case, cerebral palsy). Such statements increase parents' already strong concerns about the development of neurological pathologies after vaccination, such as autism, cerebral palsy, epilepsy, and other conditions (25). Thus, vaccination itself turns out to be a risky medical intervention, rather than a routine procedure.

Even though the regulation defines a clear list of grounds for medical exemptions, there is room for subjective interpretation of these grounds by medical personnel. In practice, the grounds for medical withdrawal turn out to be not the diagnosis and treatment of a specific disease, but long-term (months or years) observation of the child's development in case of suspected disorders. The experts interviewed, based on their personal experience, assumed that 20-50% of medical suspensions may be unjustified, and in one case a doctor suggested that inappropriate medical exemptions may be up to 90%.

Temporary medical exemptions increase the delay in the immunization calendar because parents do not show up for appointments by the end of the exemption period, nurses do not invite them, and the child continues vaccination at intervals of several months instead of one (15). One of the respondents criticized the

need to wait 2-4 weeks after acute respiratory viral infection, as in his opinion, only severe acute respiratory infection is a valid contraindication. As follows from the Order of the Ministry of Health, ARVI is "a temporary contraindication common to all types of vaccines". Consequently, there is a widespread issue of precautionary conditions being misinterpreted or overdiagnosed as absolute contraindications to vaccination.

In general, it can be stated that there is no consensus in the Kazakhstani medical community regarding the safety of immunization. Health care workers tend to overestimate the risks of AEFI after vaccination, sometimes forgetting the risks associated with the spread of vaccine-preventable infections. The same is true for parents who rely on collective immunity and prefer to delay vaccination until the child is six months, two years of age or older.

The solution to the problem may be to build and improve the system of knowledge and skills exchange, where the main tools should be systematic lectures (seminars) within the framework of professional development courses and practical trainings, business games with the involvement of recognized experts with practical experience in the field of vaccination (26). Given the role of health care workers in spreading distrust of immunization, advanced training on immunization is an effective tool to reduce the number of unwarranted refusals (27). Such training should cover a wide range of health workers who communicate with the population on vaccination issues to proactively address patient concerns, leading to increased vaccine uptake (11). Training of health workers in the procedure, criteria and practice of immunization in non-standard cases (missed vaccines in children, immunization of immunocompromised persons, pregnant women), differential diagnosis of anaphylaxis and (vasovagal) syncope, dosage and method of administration of adrenaline can also contribute to reducing the number of medical withdrawals due to lack of confidence in the health worker's ability to manage the situation (28).

Parents should be educated about the difference between a vaccine-related reaction and an adverse event that may have other causes. In addition, studies show that people are more willing to be vaccinated when vaccination rates in the population are high, indicating the role of social influence (29). In general, information about immunizations should be given well in advance of the vaccination. This gives parents time to absorb the information and ask questions that concern them and ultimately mitigates the possible desire to avoid vaccination through unwarranted medical exemptions.

At the same time, there is no possibility to analyze diagnoses for medical refusals, as qualitative data on medical refusals (diagnoses, duration) are contained only in primary medical documentation. External systemic stimulus to the adequacy of medical withdrawals should be the control of children's immunization coverage. But as interviews have shown, there are opportunities for manipulation of statistical indicators in the direction of their overestimation. As a result, the problem of medical exemptions, with many lacking adherences to evidence-based standards, remains out of the focus of attention of both the management of PHC organizations and regulatory bodies. Improvement of vaccination records depends directly on the completion of digitalization of immunization (30). This will help not only to reduce the burden on the staff of primary health care organizations, but also to establish automated monitoring and control of immunization (31). In the absence of a system of verification of PHC organizations' reporting, which would motivate the organization's management to strengthen control over medical exemptions, it is difficult to rely solely on the professionalism and initiative of health workers.

As interviewees report, not all polyclinics have implemented KMIS, and even if they have, they continue to duplicate paper-based records. At the same time, the interface of the information system requires further development, as now, when registering the fact of vaccination, manual selection of procedure parameters is required. It is important to consider that in rural areas the issue of access to the Internet has not yet been resolved, i.e. there are objective limitations to the digitalization of healthcare.

Therefore, Kazakhstan's system for tracking of exemptions and vaccine reactions lacks integration across health institutions, meaning there is no real-time integration of patient data between clinics and national databases. As a result, manual data entry leads to underreporting and discrepancies in national statistics, a problem that has also been observed in other areas of public health data in Kazakhstan, such as chronic disease surveillance (32). A significant proportion of medical refusals are already recorded by health care providers in KMIS, and this data can be collected and analyzed. This data can be used to automatically adjust vaccination schedules, automatically send reminder invitations to parents, and monitor attendance after the medical withdrawal is lifted.

Digitalization is important so that monitoring of not only vaccine coverage, but also AEFI does not depend on the special efforts of health workers but is car-

ried out in the background without diverting human resources (33). Vaccination procedures are standardized, but inconsistent post-vaccine monitoring may reduce the effectiveness of adverse event detection (34, 35). Many clinics do not systematically follow up with patients' post-vaccination. Reports of severe adverse events are rare, raising concerns about underreporting. Many parents perceive vaccine adverse event monitoring as unreliable, leading to mistrust. Moreover, physicians sometimes avoid documenting adverse events for fear of administrative scrutiny (36). Some facilities in Kazakhstan continue using paper-based records, leading to duplication and errors in digital reporting.

In comparison with international practices, in India, the online software IDSurv is used to report infectious diseases and AEFIs (37). Similarly, in many OECD and European Union countries, both the health care provider and the vaccine recipient or their representative can report an AEFI online. In Canada, incentives for timely reporting of AEFIs are provided through the inclusion of 12 major tertiary pediatric hospitals in the surveillance system Immunization Monitoring Program ACTive (IMPACT) (38). In addition to passive surveillance, international practice has used a Large Linked Databases tool to monitor vaccine and immunization safety (e.g. the Vaccine Safety Datalink project between CDC and eight health insurers). This tool offers a cost-effective and rapid means to conduct post-licensing investigations of drug and vaccine safety and allows testing of vaccine safety hypotheses.

The lack of open and comprehensive data on the status of immunization in the country generates distrust in official statistics on AEFI and vaccination coverage (39). Consequently, increasing the transparency of the immunization system and improving data collection and processing methods has the potential to increase public and medical community confidence in vaccination (40).

From the point of view of motivation to adequately prescribe medical refusals and to register AEFI, the vast majority of countries have introduced mechanisms to insure or guarantee the professional liability of health workers, including coverage of possible consequences of immunization. One example of international practice to combat the problem of inadequate interpretation of precautions is reflected in the CDC's General Recommendations for Immunization Best Practices: Guidance from the Advisory Committee on Immunization Best Practices. The document provides principles for distinguishing between contraindications and precautions. Similar documents are available in most countries, for example, in Russia there are Methodological Guidelines of the Ministry of Health of the Russian Federation MU 3.3.1.1095-02 'Medical Contraindications to Prophylactic Vaccination with National Vaccination Calendar Preparations'; in Germany, the Standing Committee on Vaccination at the Robert Koch Institute provides a list of conditions that are mistaken for contraindications to vaccination (Epidemiological Bulletin No. 34).

In Kazakhstan, to date, there are no similar by-laws, mechanisms and funds. When developing mechanisms to guarantee the professional liability of health workers, special consideration should be given to the need for legal and financial protection of health workers in case of adverse vaccine effects. However, given the status of AEFI registration in Kazakhstan, the recommendation to participate in such regional activities seems premature. Analyzing all data collected, the problem of the rising number of inappropriate medical withdrawals is caused by a whole set of reasons, which can be grouped into three broad categories: (1) legal insecurity of health care workers, (2) low qualifications of physicians, and (3) inadequate statistical recording of vaccination coverage, which leads to chronic overestimation of its indicators. Currently, any serious AEFI in Kazakhstan, even one not causally linked to vaccination, is grounds for scrupulous investigation, search and punishment of the perpetrator.

The punitive nature of AEFI monitoring results in (1) doctors over-insuring and falsely withholding immunization for any questionable case (down to "squinting eyes" in a child with epicanthus), and (2) health care providers not reporting suspected AEFI except for serious consequences that cannot be concealed. The quality of medical statistics affects the effectiveness of immunization at several levels: (1) hesitant parents overestimate collective immunity, (2) specialist doctors develop a 'tunnel vision' of the risks of vaccination for specific patients, and (3) supervisory and governing bodies (SECC, Health Departments and MoH) do not have clear and reliable data to monitor the work of PHC, analyze the epidemiological situation and identify target groups for communication work.

Policy Implications

To reduce inappropriate medical exemptions and restore confidence in vaccination, Kazakhstan's immunization system requires multi-level reform:

1. Clearer clinical guidelines: develop and disseminate evidence-based national protocols for contraindications and precautions, modeled after CDC or STIKO recommendations.

2. Targeted professional training: expand training modules for both undergraduate and in-service medical personnel to include immunization practice, AEFI response, and communication with hesitant parents.

3. Legal and institutional protection: introduce regulatory protections and no-fault compensation schemes for providers who adhere to clinical guidelines but experience adverse outcomes.

4. Strengthened digital infrastructure: complete the integration of KMIS across all PHC facilities and develop automated dashboards for exemption tracking, AEFI trends, and delayed immunization alerts.

5. Transparent communication: publicize anonymized AEFI statistics and exemption trends to foster public trust and ensure accountability within healthcare institutions.

If implemented, these interventions could improve timely vaccine uptake, reduce data manipulation, and support a culture of evidence-based decision-making.

Strength and Limitations

This study provides one of the first qualitative explorations of healthcare provider perspectives on medical exemptions in Kazakhstan. The multi-regional scope and inclusion of both clinical and administrative stakeholders provide a nuanced understanding of the structural and behavioral dynamics at play. The study has the following limitations. First, it relies on self-reported data, which may introduce bias and underrepresent the extent of unwarranted exemptions. Second, it did not involve a systematic review of individual medical records, which could have allowed for validation of clinical appropriateness. Limited availability of centralized data on unjustified medical exemptions and AEFI restricts analysis. Third, interviews were conducted during a specific period and may not reflect recent changes in practice or regulation. Finally, the findings may not be generalizable beyond Kazakhstan, although similar dynamics are likely present in other post-Soviet or LMIC contexts.

Conclusion

Kazakhstan's immunization program faces significant challenges due to the prevalence of unjustified medical exemptions and systemic inadequacies in AEFI monitoring. A persistent lack of consensus within the medical community regarding vaccine safety contributes to an environment in which healthcare providers—particularly specialized physicians such as neurologists—tend to overestimate the risks of vaccination. This often results in the overdiagnosis of precautionary conditions and the misclassification of such cases as absolute contraindications.

This leads to the problem of unjustified medical exemptions (false vaccine contraindications), especially for children. These practices undermine public trust in immunization by reinforcing parental fears, inflating the perceived risks of vaccines, and diminishing awareness of the real threats posed by vaccine-preventable diseases. As a result, vaccination is increasingly viewed not as a standard preventive measure but as a high-risk intervention that necessitates expensive pre-screening and cautious clinical oversight.

The study identified four key thematic areas that reflect the complexity of these challenges: (1) Inconsistencies in pre-vaccination monitoring practices; (2) Variability in post-vaccination follow-up procedures; (3) Divergent roles and responsibilities among stakeholders in granting medical exemptions; and (4) Surveillance and data system limitations in tracking and verifying medical exemptions.

Addressing these issues requires a multifaceted approach that includes policy reform, standardized clinical guidance, enhanced physician training, and the implementation of integrated digital health systems to improve transparency and accountability. Strengthening these areas is essential for restoring confidence in immunization, reducing the incidence of unwarranted exemptions, and improving vaccination coverage nationwide.

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